



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

29 APR 1998

FROM: HQ AFCESA/CES
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19980518 008

SUBJECT: **Engineering Technical Letter (ETL) 98-7: Fire Protection
Engineering Criteria - New Aircraft Facilities**

1. Purpose. This ETL provides fire protection criteria governing facilities housing Air Force aircraft or other aircraft on Air Force installations. These criteria provide for protection of adjacent aircraft and the facility in the event of a fuel spill fire. Human intervention is required to minimize damage to incident aircraft.

2. Application: All types of aircraft facilities, including but not limited to maintenance, servicing, and storage hangars; corrosion control hangars; fuel cell repair hangars; depot overhaul facilities; research and development (R&D)/testing facilities housing aircraft; and all types of aircraft shelters (weather, alert, semi-hardened and hardened). Compliance with this ETL is mandatory for:

- projects that have not completed the Project Definition (PD) phase;
- projects beyond the PD phase but not in active design status.

Compliance with this ETL should be considered for projects in active design beyond PD. Applying these criteria will result in reduced original construction and life-cycle maintenance costs, and increased overall reliability of the fire protection system.

2.1. New Construction: Design and construction of all new aircraft facilities on Air Force installations or housing Air Force aircraft.

2.2. Existing Facilities: Design and construction of fire protection features for all existing aircraft facilities without installed fire suppression systems. Renovation, modification, or alteration of existing aircraft facilities without installed fire suppression system will comply with the criteria contained in this ETL.

2.3. Occupancy Changes. Use of this ETL is also mandatory during a major occupancy change, such as converting a former hangar currently being used as a warehouse back to an aircraft hangar. Change of aircraft does not constitute a change of occupancy; however, beddown of a new mission is not recommended in an existing hangar without a fire suppression system.

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2.4. Integrated Combat Turn (ICT) Facilities. Criteria within this ETL apply to facilities for ICTs; however, compliance with this ETL is not authorization to conduct ICTs. ICT locations must be specifically evaluated and approved through the System Safety Engineering Program (AFI 91-202, *The US Air Force Mishap Prevention Program*).

2.5. Other Facilities: Facilities used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) within the size limitations for Group III hangars in NFPA 409, *Standard on Aircraft Hangars*, will comply with NFPA 409 requirements for Group III aircraft hangars and the suppression system requirements of this ETL.

2.6. Exempt Facilities:

- Aircraft shelters with two or fewer sides (including partial walls). These shelters will be treated as open ramps.
- Existing aircraft facilities with fire suppression systems in the aircraft servicing areas. Fire protection modification/upgrade requirements will be addressed in a separate ETL.

2.7. Authority: AFI 32-1023, *Design and Construction Standards and Execution of Facility Construction Projects*. This ETL supersedes ETL 96-1, *Fire Protection Engineering Criteria - New Aircraft Facilities*.

2.8. Effective Date: Immediately. Expires five years from date of issue.

2.9. Recipients: All Major Commands and other Air Force activities.

NOTE: Criteria in this ETL assume fire department capabilities consistent with AFI 32-2001, and a water supply and fire hydrant configuration at the hangar to support firefighting. Use of these criteria at other locations is not recommended without a complete risk analysis prepared by the base (or the project A-E for new construction) and accepted by the MAJCOM FPE and the MAJCOM Fire Department Operations (FDO) group.

3. Referenced Publications.

3.1. Air Force:

- AFI 32-1066, *Plumbing Systems*
- AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*
- AFI 91-202, *The US Air Force Mishap Prevention Program*, Chapter 9
- AFM 88-29, *Engineering Weather Data*
- Technical Order 1-1-3, *Inspection and Repair of Aircraft Internal Tank and Fuel Cells*

3.2. U.S. Army Corps of Engineers (USACE):

- Engineering Technical Letter 1110-3-484, *Design and Construction of Foam Fire Protection Systems to Protect Aircraft in Hangars*

3.3. DoD:

- MIL-HDBK-1190, *Facility Planning and Design Guide*
- MIL-HDBK-1008C, *Fire Protection for Facilities Engineering, Design, and Construction*
- MIL-F-24385F, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*

3.4. National Fire Protection Association (NFPA):

- NFPA 11, *Standard for Low-Expansion Foam*
- NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 16, *Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*
- NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*
- NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*
- NFPA 22, *Standard for Water Tanks for Private Fire Protection*
- NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 31, *Standard for the Installation of Oil Burning Equipment*
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*
- NFPA 54, *National Fuel Gas Code*
- NFPA 70, *National Electrical Code*
- NFPA 72, *National Fire Alarm Code*
- NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*
- NFPA 101, *Code for Safety to Life from Fire in Buildings and Structures*
- NFPA 231, *Standard for General Storage*
- NFPA 231C, *Standard for Rack Storage of Materials*
- NFPA 409, *Standard on Aircraft Hangars*
- NFPA 410, *Standard on Aircraft Maintenance*

NOTE: The latest edition of an NFPA standard applies.

3.5. American Society for Testing and Materials (ASTM):

- ASTM A-53, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
- ASTM A-795, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*
- ASTM D2996-95, *Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*

3.6. American National Standards Institute (ANSI):

- ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*
- ASME/ANSI B31.3-1996, *Process Piping*

3.7. Private Industry:

- Factory Mutual Loss Prevention Data Sheet 1-22, *Criteria for Maximum Foreseeable Loss Fire Walls and Space Separation*
- Factory Mutual Loss Prevention Data Sheet 1-23, *Protection of Openings*

4. Specific Requirements. This ETL, in accordance with paragraph 1.3.4 of MIL-HDBK-1008C, takes precedence over MIL-HDBK 1008C, section 4.16. This ETL is the Air Force alternative to National Fire Protection Association Standard 409 and will be used instead of that standard except as noted. Attachment 1 provides criteria and technical guidance.

4.1. U.S. Army Corps of Engineers Center of Expertise for Aircraft Hangar Fire Protection.

NOTE: Services of the Center of Expertise are provided on a cost reimbursable basis between the CoE District designing and constructing the project and the Center of Expertise. This service is expected to be covered in the standard SIOH paid on the project. This service should not result in additional costs or fees to the project.

4.1.1. For all hangar military construction (MILCON) projects on which the Corps of Engineers (CoE) is the Design Agent, the CoE Center of Expertise will review all project designs to ensure compliance with this ETL. This review is mandatory at all design review stages, and all formal review comments issued by the Center of Expertise will be implemented to the satisfaction of the Air Force IAW USACE Engineering Technical Letter 1110-3-484.

4.1.2. For all hangar MILCON projects on which the CoE is the Construction Agent, the CoE Center of Expertise will review all contractor shop submittals to ensure compliance with this ETL. All review comments issued by the Center of Expertise will be implemented by the CoE's Contracting Officer to the satisfaction

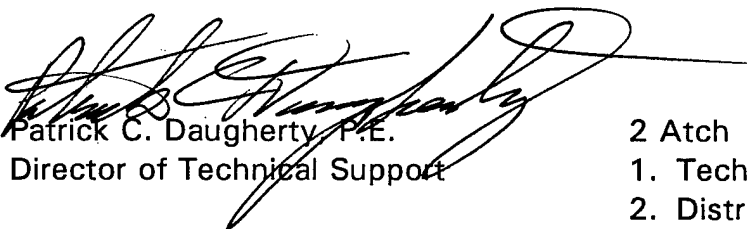
of the Air Force. An FPE in the office of the Center of Expertise will perform the final acceptance testing of all hangar fire protection systems. The MILCON project will not be accepted by the CoE Contracting Officer until the CoE Center of Expertise has accepted the fire protection systems.

4.2. Naval Facilities Engineering Command (NAVFACENGCOM) Division Fire Protection Engineer.

4.2.1. For all hangar MILCON projects on which NAVFAC is the Design Agent, the Division Fire Protection Engineer will review all project designs to ensure compliance with this ETL. This review is mandatory at all design review stages, and all formal review comments issued will be implemented to the satisfaction of the Air Force.

4.2.2. For all hangar MILCON projects, the Division Fire Protection Engineer will review all contractor shop submittals to ensure compliance with this ETL. All review comments will be implemented by the Contracting Officer to the satisfaction of the Air Force. A Fire Protection Engineer will perform the final acceptance testing of all hangar fire protection systems.

5. Point of Contact. Fire protection criteria for aircraft facilities must evolve concurrently with technical developments in fire science, data generated in fire testing programs, and the availability of new fire protection equipment or methodologies. Recommendations for improvements to this ETL are encouraged and should be furnished to Mr. Fred Walker, HQ AFCEA/CESM, DSN 523-6315, commercial (850) 283-6315, FAX DSN 523-6219, Internet: walkerf@afcesa.af.mil.



Patrick C. Daugherty, P.E.
Director of Technical Support

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1. Technical Criteria
2. Distribution List

TECHNICAL CRITERIA

AIR FORCE AIRCRAFT HANGAR FIRE PROTECTION

A1. Construction Requirements.

A1.1. Structural Requirements. All new aircraft hangars will be exclusively noncombustible construction IAW Uniform Building Code (UBC) requirements for any category of Type I or Type II construction. Tension fabric structures on metal structural frames are considered to meet this construction type requirement. Facilities used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) meeting the space requirements of NFPA 409, *Standard on Aircraft Hangars*, for Group III structures must comply with criteria in NFPA 409 for Group III hangars and paragraph A3.1.1.4.

A1.1.1. Fire-Rated Construction. Protection of structural members (columns, beams, trusses, joists) is not required in a facility protected by an approved fire suppression system in compliance with this ETL.

A1.1.2. Internal Fire-Rated Separations. When Air Force aircraft assets are co-located in a facility with non-DoD operations that are beyond the control of the DoD activity, the Air Force aircraft assets will be isolated from the non-DoD areas by 4-hour rated firewalls. Penetrations of such firewalls must be minimized. Any necessary door, window, and other penetration must be protected IAW Factory Mutual Loss Prevention Data Sheets 1-22, *Criteria for Maximum Foreseeable Loss Fire Walls and Space Separation*, and 1-23, *Protection of Openings*.

A1.1.2.1. To allow the greatest operational flexibility in Air Force hangars covered by this ETL, fire-rated walls and partitions are not required between adjacent aircraft servicing areas when the nature of the occupancy is similar in both bays. Operations such as fuel cell maintenance, integrated combat turns (ICT), and indoor refueling, must be separated from general maintenance by walls of masonry construction, having not less than a 1-hour fire rating with 45-minute opening protection. Such walls will extend from the floor to the underside of the roof deck.

A1.1.2.2. Except in facilities containing only unfueled aircraft, all operations outside the aircraft servicing area must be isolated from the aircraft servicing area by a masonry wall having a fire resistance rating of at least 1 hour. This wall will extend from the concrete floor to the roof. All openings in this wall will be automatic-closing or self-closing and will be rated for at least 45 minutes. (These areas must be fully sprinklered IAW other sections of this ETL.)

A1.1.3. Allowable Floor Area.

A1.1.3.1. The allowable floor area of a facility is unlimited when all of the following conditions are met:

- 100 percent of the facility is sprinklered IAW this ETL;
- water supply to the sprinkler systems is in full compliance with the criteria in this ETL;
- separations from adjacent structures complies with paragraph A1.1.4 of this ETL;
- internal separation walls comply with paragraph A1.1.2 of this ETL.

A1.1.3.2. Facilities not meeting the above conditions will be limited to the floor areas contained in the latest edition of the Uniform Building Code for Occupancy type B-3; except facilities used for fuel cell maintenance, ICT, or indoor refueling/defueling, which will be Occupancy type H-5.

A1.1.4. Siting/Separation. No separation is required between any combination of Type I or Type II construction hangars protected by approved fire suppression systems.

A1.1.4.1. Separation Between Adjacent Maintenance Hangars of Mixed Construction. The minimum separation distance between adjacent hangars is 12 meters (40 feet). This may be reduced to 7.5 meters (25 feet) if one of the hangars has a 1-hour exposure wall and protected 3/4-hour openings (e.g., windows, doors), or if both hangars have approved fire suppression systems. This may be further reduced to 3 meters (10 feet) if both hangars have 1-hour exposure walls and protected 3/4-hour openings.

A1.1.4.2. Separation Between Hangars and Other Buildings. Minimum separation between hangars and other buildings is 12 meters (40 feet). Reductions in this distance must conform to the Uniform Building Code.

A1.1.4.3. Separation Between Tension Fabric Hangars and All Other Structures. Minimum separation between tension fabric structures and other structures will be 30 meters (100 feet) with a clear zone of 15 meters (50 feet) immediately adjacent to the tension fabric structure. The clear zone can not be used for storage and must be clear of vegetation. (Maintained lawn is permitted.) The clear zone may be used as a street or driveway, but not for vehicle parking.

A1.1.5. Draft Curtains.

A1.1.5.1. Provide draft curtains surrounding each sprinkler system for all hangars. Extend draft curtains down from the roof (or ceiling) not less than one-eighth of the distance from the roof (or ceiling) to the floor. When roof structural supports

extend below the roof or ceiling, suspend draft curtains to the lowest member of the structural supports, or one-eighth the distance from the roof or ceiling, whichever is greater.

A1.1.5.2. Install draft curtains to form rectangular roof pockets. Install draft stops on exposed structural roof supports whenever possible.

A1.2. Utility Systems.

A1.2.1. Floor Drainage.

A1.2.1.1. Outside the Hangar. Aprons and the approach into the hangar must be sloped away from the hangar with a grade of not less than one-half of one percent (0.3:60 meters [1:200 feet]) to preclude a ramp fuel spill from entering the hangar. If the required grade cannot be achieved, provide an appropriately sized trench drain across the entire apron side of the hangar with a discharge to a safe location remote from the hangar.

A1.2.1.2. Inside the Hangar. Floor elevations within the hangar must be arranged to prevent a liquid spill within the aircraft servicing area from flowing into adjacent areas.

A1.2.2. Heating Systems.

A1.2.2.1. Install heating equipment IAW NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Standard for the Installation of Oil Burning Equipment*; or NFPA 54, *National Fuel Gas Code* (for exceptions, see Note.)

A1.2.2.2. For radiant heating, install overhead radiant tube systems. Do not install any heater with a flame or glowing element open to the atmosphere in the aircraft servicing area.

A1.2.3. Electrical Systems.

A1.2.3.1. Install electrical equipment in general maintenance aircraft hangars in accordance with NFPA 70, *National Electrical Code*, NEC Article 513.

A1.2.3.2. Install electrical equipment in hangars for fuel system maintenance operations involving aircraft serviced with JP-8 (or another combustible fuel at a temperature below its flash point) in accordance with NFPA 70, *National Electrical Code*, NEC Article 513.

NOTE: Technical Order 1-1-3, *Inspection and Repair of Aircraft Internal Tank and Fuel Cells*, additionally requires all outlets in the aircraft servicing area to be Class I Division 2 rated. This is an aircraft maintenance (user) safety requirement, not a fire safety issue. Questions should be directed to the command fuels system maintenance office or the T.O. manager at Warner Robins Air Logistics Center.

A1.2.3.3. Requirements in paragraphs A1.2.3.3.1 and A1.2.3.3.2 apply to installed electrical equipment in hangars with the following operations:

- refueling or defueling regardless of fuel type (other than that associated with fuel system maintenance);
- ICTs regardless of fuel type, and
- fuel system maintenance operations with flammable fuels including JP-4 (or a combustible fuel at a temperature above its flash point).

A1.2.3.3.1. Electrical equipment above the floor in the aircraft servicing area up to the height of the highest hangar door must satisfy NEC criteria for Class I Division 2 locations.

A1.2.3.3.2. Electrical equipment outside the classified area in the aircraft maintenance area, including lights, must conform to NEC Article 513.

A1.2.3.4. In hangars where the rate of spray paint application exceeds one quart per hour or the cumulative application of more than one gallon over an eight-hour period, install electrical equipment IAW NFPA 33, *Spray Applications Using Flammable or Combustible Materials*.

A1.2.4. Fire Hydrants.

A1.2.4.1. Fire hydrants will be supplied from the domestic (potable) water system around the hangar IAW MIL-HDBK 1008C, *Fire Protection for Facilities Engineering, Design, and Construction*, section 5.7.3. Hydrants will not be supplied by the fire protection water system. Hose threads on hydrants must match those used by the base fire department. Locate hydrants servicing the apron side of the hangar at the hangar corners, within 30 meters (100 feet) of the hangar and out of the way of moving aircraft. Do not use flush-mounted hydrants in the pavement. Install wall hydrants in the side of the hangar supplied by the domestic water system if conventional hydrants cannot be used on the apron side of a hangar. Properly label wall hydrants and provide a wall indicator valve to open the hydrant from outside the hangar.

A1.2.4.2. Install water mains supplying hydrants IAW MIL-HDBK 1008C.

A1.2.5. Foam-Water Retention Systems. Retention systems are not required for

facilities/systems designed and constructed in accordance with this ETL. Foam-water retention is not required in the following cases:

- In geographic regions where there is little or no open water, streams, or wetlands, and no high-ground water table. (Solar evaporation is an appropriate disposal method in these areas.)
- For testing discharges of any systems discussed in this ETL (test headers are required on all new foam-water systems allowing controlled discharge into a tank or other portable collection device, so no retention capability is required).
- For wet-pipe and pre-action systems, since the closed heads prevent accidental discharge.
- For high-expansion foam systems, because the highly expanded foam contains little liquid and is impractical to control.
- For low level foam water nozzle systems, properly installed and maintained these systems do not have discharges. Unplanned accidental discharges are not "most probable worst case" event.
- For catastrophic events, such as actual fires. Foam discharge associated with a fire is not a "most probable worst case" event. A fire in a hangar is a catastrophic event. Designing a containment system for a catastrophic event is impractical due to the number of associated variables and the mass of fire debris generated.

A1.2.5.1. Unplanned Accidental Events. Current environmental guidance for management of unplanned accidental AFFF discharges is:

- a formally documented response plan by the installation spill team and/or off-base contractors to contain, collect and dispose of discharged AFFF.
- direct release to a government-operated sanitary or industrial waste treatment facility, if the foam-water solution is less than 50 parts per million of the plant influent.

A1.2.5.2. Other Retention Issues. For additional guidance or information on AFFF retention and management, consult with HQ USAF/ILEV and/or MAJCOM/CEV offices

A2. Accessibility for Firefighting.

A2.1. Exterior Firefighting. Provide fire apparatus access on at least two complete sides of every hangar. Suitable access surfaces include ramps, aircraft parking aprons, automotive parking areas, and fire apparatus access roads.

A2.1.1. Automotive Parking Areas. Automotive parking areas used for fire department access must include at least one aisle 5.4 meters (18 feet) wide with adequate turning radius for fire department apparatus.

A2.1.2. Fire Department Access Roads. Fire department access roads must be at least 5.4 meters (18 feet) wide, designed to support imposed loads of fire apparatus, and provide all-weather driving capabilities. Where fire department access roads are covered by mowed lawns, use bollards to mark the limits of the supporting surface. Fire department access roads over 45 meters (150 feet) long must allow fire apparatus to drive through or turn around. Fire department access roads must not be used for any other purpose, and should be secured with gates, bollards, or similar devices to restrict use.

A2.2. Interior Firefighting.

A2.2.1. Hangar Doors. Hangar doors must operate under emergency conditions. The electrical supply for power-operated doors must be independent of the building power supply to permit isolation of power to the facility during a fire without interrupting power to door motors.

A2.2.1.1. Configure hangar doors for manual operation without special tools or disassembly.

A2.2.1.2. Use door track heaters in areas subject to freezing to prevent accumulated snow and ice from impeding operation of hangar doors.

A2.2.1.3. Provide a key-operated switch on the exterior of the facility for control of power.

A2.2.2. Personnel Doors. Personnel doors satisfying requirements of the Life Safety Code, Industrial Occupancies Chapter, Special Provisions for Aircraft Servicing Hangars Section (NFPA 101, *Code for Safety to Life from Fire in Buildings and Structures*) will provide adequate access into the hangar for normal structural firefighting operations.

A3. Fire Suppression Systems.

A3.1. General Requirements.

A3.1.1. Applicable Design Standards and Criteria. Provide automatic sprinkler protection in all areas of aircraft facilities (including shop, administration, and all other areas). Sprinkler protection must be designed for the occupancy hazard present IAW this ETL, MIL-HDBK 1008C, and the following NFPA Standards:

- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*
- NFPA 231, *Standard for General Storage*
- NFPA 231C, *Standard for Rack Storage of Materials*

When there is a conflict between this ETL and any provisions of an NFPA standard or code, this ETL will take precedence.

A3.1.1.1. Protect areas used exclusively for unfueled aircraft (IAW Technical Order 1-1-3) with conventional wet-pipe sprinkler systems designed for Ordinary Hazard Group 2 occupancy (8.0 lpm/m² over 270 square meters [0.2 gpm/ft² over 3000 square feet]).

A3.1.1.2. Protect areas used for fueled aircraft with either of the following suppression systems (system selection should be based on an economic and mission analysis and approved by the MAJCOM):

- A conventional wet-pipe sprinkler system (8.0 lpm/m² over 1400 square meters [0.2 gpm/ft² over 15000 square feet]) and one of the following low-level fuel spill fire suppression systems:
 - High-expansion foam system providing a minimum foam depth of 1.0 meters (3 feet) over the entire aircraft servicing area and adjacent undivided areas.
 - Low-level foam-water nozzle system providing 4.0 lpm/m² (0.1 gpm/ft²) over the aircraft servicing area.
- A closed-head (wet pipe or pre-action) foam-water sprinkler (6.5 lpm/m² over 1400 square meters [0.16 gpm/ft² over 15,000 square feet]) when the maximum floor to ceiling height is 12 meters (40 feet) or less.
- A closed-head (wet pipe or pre-action) foam-water sprinkler system (6.5 lpm/m² over 465 square meters [0.16 gpm over 5000 square feet]) and a low-level foam-water nozzle system (4.0 lpm/m² [0.1 gpm/ft²] over the aircraft servicing area) when the floor to ceiling height is greater than 12 meters (40 feet).

A3.1.1.3. Protect dedicated single-aircraft facilities used exclusively for non-destructive inspection (NDI) (e.g., x-raying) of fueled aircraft with no aircraft maintenance or servicing operations with conventional wet-pipe sprinkler systems designed for Extra Hazard Group 1 occupancy (12.0 lpm/m² over 270 square meters [0.3 gpm/ft² over 3000 square feet]).

A3.1.1.4. Protect Group III hangars used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) with conventional wet-pipe sprinkler systems designed for Extra Hazard Group 1 occupancy (12 lpm/m² over 270 square meters [0.3 gpm/ft² over 3000 square feet]).

A3.1.2. Manual Foam-Water Fire Hose Stations. Do not provide interior or exterior foam-water hose stations or fire hose connections.

A3.1.3. Fire Department Connections. Do not provide fire department connections on foam-water systems.

A3.1.4. Strainers. Provide basket-type strainers upstream of risers on all foam-water systems.

A3.1.5. Test Header. Provide a test header for all overhead foam-water systems and all foam-water nozzle systems. Locate the header inside the aircraft servicing area as near as practical to an outside door. Configure the test header to permit each proportioner to be individually tested. Each test header must have at least four valved 2.5-inch (no equal metric standard) hose fittings.

A3.1.6. Underground Piping. Install underground piping systems, including piping in fire pump systems, IAW NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*, and the following:

A3.1.6.1. Provide ductile iron pipe or other pipe (high density polyethylene or filament-wound fiberglass) listed by Underwriters Laboratories or approved by Factory Mutual for buried fire service application for all underground uses.

A3.1.6.2. Do not install any piping under hangar/facility floor slabs. If piping must be located below the floor line, use concrete trenching with open steel grating. Do not install any piping, including the fire protection water service entrance into the building, that allows pressurization of the space below the floor slab. Minimize piping under paved operational surfaces (taxiways and aircraft parking).

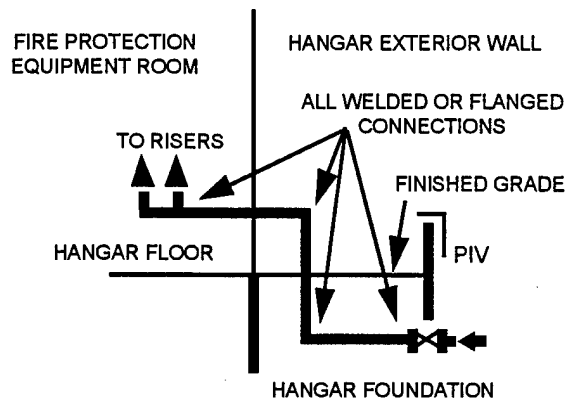


Figure A1. Water Supply Pipe Entry

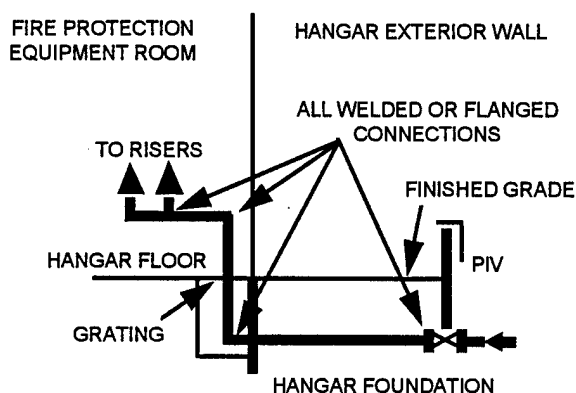


Figure A2. Water Supply Pipe Entry

A3.1.6.3. Size underground mains to ensure the maximum flow velocity does not exceed 3 meters per second (10 feet per second).

A3.1.6.4. Use flanged or welded fittings (Figures A1 and A2) to transition the fire protection water service entrance from horizontal to vertical as it enters the building. Do not use gasketed compression fittings (including locking type) or flange fittings with setscrews.

A3.1.6.5. Provide corrosion protection on underground fire mains in the same manner as required for the domestic water and other buried piping at the location.

A3.1.6.6. Do not install piping carrying foam concentrate or foam-water solution underground.

A3.1.7. Backflow Prevention. Install backflow prevention devices at connections to domestic water distribution systems. Backflow prevention is not required in dedicated non-potable water distribution systems. Valves that are part of a backflow prevention assembly will be the indicating type and will be supervised. Omit post indicator valves when backflow preventers are located outside. Locate backflow preventers inside the protected buildings when freeze protection is required. Do not use heat tapes or tracings to provide freeze protection; however, in locations where simple insulation will provide adequate freeze protection, the backflow preventer may be located outside. (See AFI 32-1066, *Plumbing Systems*.)

A3.1.7.1. Connections between potable water systems and systems containing foam will use reduced-pressure backflow preventers.

A3.1.7.2. Connections between potable water systems and systems that do not contain chemicals (e.g., wet pipe systems) will use double-check valve assemblies unless otherwise required by local health/water authorities.

A3.1.7.3. Install backflow prevention on the discharge side of pumps supplied directly from domestic water systems.

A3.1.8. Interior Piping Systems.

A3.1.8.1. Limit maximum flow velocity in interior facility piping to 6 meters per second (20 feet per second) or less.

A3.1.8.2. For water systems, use standard-weight pipe conforming to ASTM A-795, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, or ASTM A-53, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*.

A3.1.8.3. For foam-water systems, use:

- standard weight pipe conforming to ASTM A-795, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use* (Exception: Do not use galvanized pipe), or ASTM A-53, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*;

or

- filament-wound fiberglass pipe conforming to ASTM D2996-95, *Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*, designation code "RTRP-11 FF-3121."

Note: Filament-wound fiberglass pipe must be installed in accordance with ASME/ANSI B31.3-1996, *Process Piping*.

A3.8.1.4. Use threaded, flanged, or grooved fittings. Do not use fittings which couple plain end pipe. Do not use welded sprinkler fittings or outlets for foam-water solution.

A3.8.1.5. Paint all exposed interior piping (color to be the same as the walls/ceiling or a complementing color). Stainless steel piping may be cleaned and left unpainted.

A3.1.8.6. Mark all exposed interior piping, at 8-meter (26-foot) intervals, with plastic wraparound-type pipe labels conforming to ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*, indicating the type of fluid carried and direction of flow. Labels are not required on sprinkler system branch lines and

pipes less than 2 inches (5.08 centimeters) nominal size. The following legends are required:

- FIRE PROTECTION WATER - used on dedicated potable and non-potable fire protection water supply lines.
- FOAM CONCENTRATE - used on AFFF and high expansion foam concentrate lines.
- FOAM NOZZLE - used on lines supplying low-level foam-water nozzles.
- FOAM SPRINKLER - used on lines supplying overhead AFFF/FOAM wet pipe, deluge, and pre-action sprinkler systems.
- FIRE SPRINKLER or SPRINKLER FIRE - used on standard water-only sprinkler systems.
- HIGH EXPANSION FOAM - used on lines supplying high expansion foam generators.

A3.2. Automatic Sprinkler System.

A3.2.1. Use a wet-pipe automatic sprinkler system in geographic areas having a 99% dry bulb temperature greater than -17.7°C (0°F) (per AFM 88-29, *Engineering Weather Data*). See paragraph A5.4 pertaining to building temperature supervision when the 99% dry bulb temperature is less than -0.5°C (33°F) (per AFM 88-29).

A3.2.2. Use a pre-action automatic sprinkler system activated by a roof- or ceiling-level thermal detection system, as described in paragraph A3.7.2 of this ETL, in geographic areas having a 99% dry bulb temperature less than -17.7°C (0°F) (per AFM 88-29).

A3.2.2.1. Provide externally re-setable (without opening the valve assembly and without use of special tools) automatic water control (deluge) valves for pre-action systems. Maximum valve size is 150 millimeters (6 inches).

A3.2.2.2. Do not provide supervisory air on pre-action sprinkler systems in aircraft servicing areas.

A3.2.3. Limit the area protected by an overhead sprinkler system to a maximum of 1400 square meters (15,000 square feet) per riser. When multiple systems are required in an aircraft servicing area, all overhead systems will cover essentially equal floor areas.

A3.2.4. Provide upright quick response sprinklers at the roof or ceiling level with temperature ratings of 79.4°C (175°F).

A3.3. Foam-Water Sprinkler Systems.

A3.3.1. Use a wet-pipe foam-water sprinkler system in geographic areas having a 99% dry bulb temperature greater than $-17.7\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$) (per AFM 88-29). See paragraph A5.4 pertaining to building temperature supervision when the 99% dry bulb temperature is less than $-0.5\text{ }^{\circ}\text{C}$ ($33\text{ }^{\circ}\text{F}$) (per AFM 88-29).

A3.3.2. Use a pre-action foam-water sprinkler system activated by a roof- or ceiling-level thermal detection system, as described in paragraph A3.7.2 of this ETL, in geographic areas having a 99% dry bulb temperature less than $-17.7\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$) (per AFM 88-29).

A3.3.2.1. Provide externally re-setable (without opening the valve assembly and without the use of special tools) automatic water control (deluge) valves for pre-action systems. Maximum valve size will be 150 millimeters (6 inches).

A3.3.2.2. Do not provide supervisory air on pre-action sprinkler systems in aircraft servicing areas.

A3.3.3. Limit the area protected by an overhead sprinkler system to a maximum of 1400 square meters (15,000 square feet) per riser. When multiple systems are required in an aircraft servicing area, all overhead systems will cover essentially equal floor areas.

A3.3.4. Provide 15 mm (0.5 inch) orifice upright quick response sprinklers at the roof or ceiling level with temperature ratings of $79\text{ }^{\circ}\text{C}$ ($175\text{ }^{\circ}\text{F}$).

A3.3.5. Minimum design density for every sprinkler head in the aircraft servicing area must be 6.5 lpm/m^2 (0.16 gpm/ft^2) when the system is discharging over the operating areas. Maximum discharge from any sprinkler must not exceed 7.0 lpm/m^2 (0.20 gpm/ft^2).

A3.3.6. Provide an inspector test valve on each system and provide low point drains for all sections of piping not draining back to the main drain.

A3.3.7. Provide a surge arrester (expansion tank) not less than 38 liters (10 gallons) capacity for each separate wet pipe riser. Tanks must be listed/approved as a surge arrester with a rated working pressure not less than 1895 kPa (275 psi).

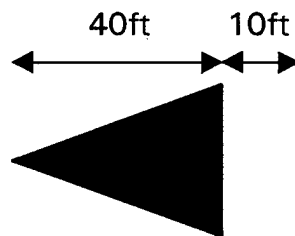
A3.4. Foam-Water Nozzle Systems.

A3.4.1. Flow Rate. Limit individual foam-water nozzle flow rates to less than 1900 lpm (500 gpm). Provide additional nozzles at alternate locations as required.

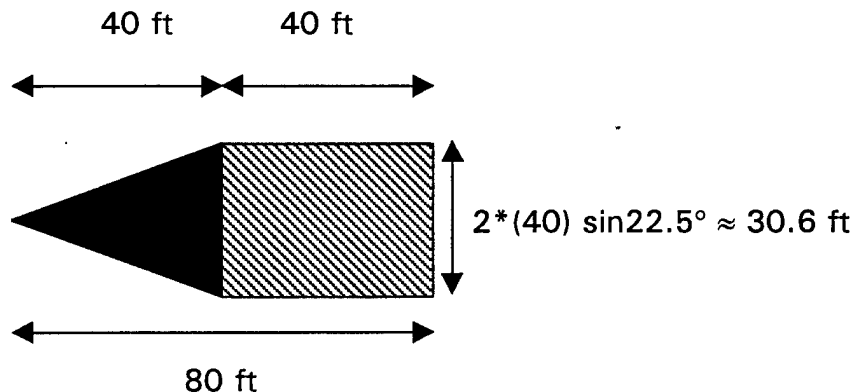
A3.4.2. Pre-charging. Precharge the foam-water system with foam-water solution up to the automatic water control valve (deluge valve), located at each foam-water nozzle.

A3.4.3. Application Rate. The foam-water application rate from foam-water nozzle systems is 40 lpm/m² (0.10 gpm/ft²) over the protected area.

A3.4.3.1. In aircraft servicing areas dedicated to a single aircraft having a fixed parking position, cover the entire shadow area of the aircraft. The area under engines extending beyond the wing edge and under rear elevators does not have to be considered in the aircraft's shadow area. It is not necessary for the foam-water nozzle discharge pattern (throw) to cover the entire aircraft shadow area – the foam is more effective in suppressing fuel spill fires when it flows across the floor into the shadow area. Apply the foam-water nozzle discharge no closer than 3 meters (10 feet) from the edge of the shadow area and push the foam under the aircraft. For example, if the manufacturer's literature indicates a nozzle discharges 40 feet:



Foam-water nozzle coverage will be based on twice the throw distance (d) by the width at widest point ($2d \sin \theta/2$). For example, if the manufacturer's literature indicates a nozzle has a 45 degree pattern and discharges 40 feet, $d = 40$ and $\theta = 45$.



A3.4.3.2. In aircraft servicing areas with flexible parking positions or a variety of aircraft, cover the entire floor area up to 6 meters (20 feet) from the walls.

A3.4.3.3. Use fixed non-aspirating nozzles or fixed short barrel aspirating nozzles. Select foam-water nozzle size and locations to provide maximum efficiency in covering the aircraft shadow area(s) without distributing foam onto any aircraft surface.

A3.4.3.3.1. Align foam-water nozzle elevations to push the foam across the floor with minimal agitation of the pool fire. It is critical that foam-water nozzles be located and positioned so as not to spray foam-water solution onto any aircraft surface, especially inside aircraft engines, doors, or hatches.

A3.4.3.3.2. Locate foam-water nozzles to avoid obstructions (structural components, aircraft components) interfering with the discharge pattern.

A3.4.3.3.3. Locate foam-water nozzles at least 3 meters (10 feet) away from the wall to permit storage of aerospace ground equipment (AGE), tools, and aircraft components behind the foam-water nozzles. Install piping to foam-water nozzles in trenches in the floor covered with steel grating. Do not run piping under concrete floors.

NOTE: This provides users the maximum usable floor space and minimizes the area which must be kept clear in front of the nozzles to prevent blocking the foam delivery.

A3.4.3.3.4. Provide bollards to protect foam-water nozzle locations. Locate bollards so that all parts of the foam-water nozzle assembly, including the full sweep of any oscillating nozzle, are within the bollards' protection.

A3.4.3.3.5. Do not provide manual activation devices as part of the listed valve trim installed on each deluge valve.

A3.4.3.3.6. Oscillating monitor non-aspirating foam-water nozzles may only be used when fixed nozzles cannot provide the required coverage.

A3.4.4. Activation. Activate the foam-water nozzle systems using any one of the following:

- Manual foam activation stations located at main exits from aircraft servicing area (if provided).
- Waterflow signal in wet-pipe overhead systems.
- Roof- or ceiling-level heat detection systems associated with pre-action systems (if installed).

A3.4.5. Provide a surge arrester (expansion tank) not less than 38 liters (10 gallons) capacity for each separate foam-water nozzle riser. Tanks must be listed/approved as a surge arrester with a rated working pressure not less than 1895 kPa (275 psi).

A3.5. High Expansion Foam Systems. High expansion foam systems are designed as total flooding systems IAW NFPA 11A, *Standard for Medium and High Expansion Foam Systems*.

A3.5.1. Application Rate. High expansion foam systems must deliver sufficient foam to cover the aircraft servicing area and adjacent accessible areas to a depth of 1 meter (3 feet) in 4 minutes or less.

A3.5.1.1. Concentrate and water supply will permit continuous operation of the system to generate four times the submergence volume (A3.5.1) but not less than 15 minutes. No additional foam is required for maintenance of the submergence volume beyond this 15 minutes.

A3.5.1.2. Do not supply connected reserve concentrate.

A3.5.2. Installation. Locate high expansion foam generator(s) in the hangar ceiling so that foam discharge falls close to but not directly on the aircraft fuselage or wings. High expansion foam generators should be designed to use outside air for foam generation except where snow accumulation on the roof may block or limit airflow.

A3.5.3. Power Supply. High expansion foam generators may be either hydraulically- (water-) or electrically- powered. Electrically-powered high expansion foam generators should be supplied ahead of the building disconnect and do not require a secondary power source when the power source meets the reliability requirements in paragraph A4.3.2

A3.5.4. Activation. Activate the high expansion foam systems using any one of the following:

- Manual foam activation stations located at main exits from aircraft servicing area.
- Waterflow signal in overhead systems.
- Roof- or ceiling-level heat detection systems associated with pre-action systems (if installed).

A3.6. Foam Proportioning Systems.

A3.6.1. Listing. All components and assemblies used in this fire protection subsystem must be specifically listed/approved for their intended use by a nationally recognized testing organization whose listing/approval process includes follow-up factory inspections to ensure that products comply with the listing/approval conditions.

A3.6.2. Concentrate.

A3.6.2.1. AFFF. Use only aqueous film forming foam (AFFF) concentrates complying with the current military specification (MIL-F-24385F, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*).

A3.6.2.2. High Expansion. Use only high expansion foam (Hi-Ex) concentrates listed/approved for use with the foam generators installed.

A3.6.3. Location. Provide independent concentrate storage and proportioning systems for each aircraft hangar facility. Locate foam concentrate storage, foam proportioning, foam injection and system risers in a dedicated fire protection equipment room isolated from the aircraft servicing area by construction rated for at least one hour. These rooms must have direct exterior access.

A3.6.3.1. The foam equipment room will be large enough to accommodate all required equipment. All equipment will be fully accessible for inspection, testing, maintenance, and removal/replacement without the removal of any other equipment.

A3.6.3.2. If any equipment and/or valves requiring access for maintenance or periodic testing are located more than 2.4 meters (8 feet) above the floor, provide an open steel grate mezzanine, with a permanent ladder, at that equipment level. All platforms and ladders must be in compliance with OSHA requirements.

A3.6.4. Proportioning.

A3.6.4.1. Proportioners will be limited to 15.24 centimeters (6 inches) or less.

A3.6.4.2. Use in-line balanced-pressure (ILBP) proportioners on all pumped concentrate systems. Do not use ILBP proportioners on bladder tank systems. ILBP proportioners must be factory assembled and tested by the manufacturer, and the entire ILBP proportioner assembly must be listed/approved by a recognized laboratory. Disassembly, reassembly, and/or modification by the installing contractor will be prohibited.

A3.6.4.2.1. Design concentrate pumping systems to deliver the required flow when the largest capacity concentrate pump is out of service.

A3.6.4.2.2. Provide a pressure maintenance pump when the length of concentrate piping between the concentrate pump and the point of injection exceeds 14.5 meters (50 feet).

A3.6.5. Control Valve. Provide water-powered ball valves as foam concentrate control valves. The valve must be operated by connection to the alarm line of the automatic water control valve or alarm valve. Provide a retard chamber in the line to the water-powered ball valve on wet pipe foam water systems.

A3.6.6. Application Time.

A3.6.6.1. For foam-water sprinklers and foam-water nozzles, provide a connected foam concentrate supply sized for a single 10-minute application of foam, based on the actual system flow in the least hydraulically demanding area.

A3.6.6.2. For high expansion generators, provide a connected foam concentrate supply sized for a single 15-minute application (or four times the submergence volume, whichever is greater) of foam.

A3.6.7. Concentrate Storage. Provide a single foam concentrate tank. Atmospheric foam storage tanks must be either plastic or fiberglass construction and listed/approved for the storage of foam concentrate. Pressure tanks for bladder tank systems must be steel and listed/approved for the storage of foam concentrate.

A3.6.7.1. Do not provide back-up supply of foam concentrate in the facility, either as a connected reserve or bulk reserve.

A3.6.7.2. Limit bladder tanks to the horizontal type only. Provide clear space at one end of the tank, at least equal to the length of the tank, to permit bladder replacement. Doors to the outside at the end of the tank are an acceptable alternative.

A3.6.8. Foam Concentrate Pipe: Foam concentrate pipe must satisfy the following criteria:

- Grooved, welded, or flanged stainless steel.
- Filament-wound fiberglass meeting not less than ASTM D2996-95, *Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*, designation code "RTRP-11 FF-3121," installed in accordance with ASME/ANSI B31.3-1996, *Process Piping*.

A3.7. Foam System Detection and Controls. Design all foam system detection and controls IAW NFPA 72, *National Fire Alarm Code*, and the following criteria.

A3.7.1. Foam System Control Panel (FSCP).

A3.7.1.1. Locate all FSCPs in the fire protection equipment room, in a clean environment having temperature and humidity control IAW the unit's listing/approval.

A3.7.1.2. Transient Voltage Surge Suppression (TVSS).

A.3.7.1.2.1. All FSCPs must have TVSS on all fire alarm circuits entering and leaving the facility, including but not limited to the power supply circuits to the FSCP, circuits interfacing with fire pumping stations outside the facility, and circuits interfacing with the fire alarm receiving station (such as communication circuits or antenna systems).

A.3.7.1.2.2. Alternating Current (ac) Power TVSS Devices. These devices will have been tested in accordance with UL 1449 (Second Edition) and UL 1283 (latest edition) by a nationally recognized testing laboratory. The TVSS devices must provide normal sine wave tracking, with Category A1 ring wave suppression (2,000-Volts, 67-Amperes, 180-degrees) of less than 50-Volts (V) for nominal 120-Vac legs. The TVSS will provide independent, distinct, and dedicated circuitry for each possible protection mode (i.e., line-to-line, line-to-neutral, line-to-ground, neutral-to-ground). TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

A.3.7.1.2.3. Data, Signal, and Control Wire TVSS Devices. The TVSS device must be designed by the same manufacturer as the ac power TVSS devices to ensure overall compatibility and system reliability. The TVSS manufacturer will provide the TVSS devices based on evaluation of individual system parameters, including: conductor size and length, number of conductors, shield type, peak current and voltage, signal type, signal baud rate, frequency bandwidth, maximum attenuation, maximum standing-wave-ratio, and maximum reflection coefficient. TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

A3.7.1.3. Provide an FSCP for all suppression and detection functions in the aircraft area. The FSCP must be fully compatible with the base fire alarm receiving system without field modifications to any system hardware or software.

A3.7.1.3.1. The FSCP must transmit a separate and distinctive fire signal to the fire department upon activation of any portion of the foam-water system. Separate fire alarm transmitters/receivers will be permitted when they are fully compatible with the FSCP and the base fire alarm receiving system without field modifications to the FSCP.

A3.7.1.3.2. The specific number of alarm signals (e.g., fire, supervisory, tamper) to be transmitted must be defined in the system matrix (Figures A3 and A4).

A3.7.1.4. Control panels activating deluge, pre-action, or nozzle systems must be listed/approved as releasing panels. All releasing panels must be specifically listed/approved for use with the automatic water control valves/solenoid release valves specified for the fire suppression system. Provide a switch within the lockable control panel to disable the releasing functions of the panel while leaving all detection and other functions of the panel operational. Activation of this switch will transmit a trouble signal to the fire alarm center.

A3.7.2. Thermal Fire Detectors.

A3.7.2.1. To activate pre-action systems, provide one of the following automatic fire detection systems at the underside of the roof of the aircraft servicing area.

- Rate-compensated fire detectors having a temperature rating between 71 °C (160 °F) and 76 °C (170 °F). Maximum area of coverage per detector will be 56.25 square meters (625 square feet).
- Linear thermistor (line-type electrical conductivity) fire detector having a temperature setting of 76 °C (170 °F). Maximum spacing between detection lines is 9 meters (30 feet). Manufacturer must verify by their approved test method the detector response setting after installation. On steeply sloped or curved roofs, thermistor detectors must be installed perpendicular to the slope or arc (along the axis of the curve).

A3.7.2.2. The area covered by the fire detection system must correspond with its affiliated roof-level sprinkler system bound by draft curtains. The activation of any heat detection device in the sprinkler zone will immediately:

- Send a start signal to the fire pumping system (if any).
- Activate all low-level fuel spill fire suppression systems in the aircraft servicing area of fire origin.
- Actuate the appropriate suppression system valves (e.g., pre-action valves, foam concentrate valves) for the floor area covered by the detection system.

Figure A3. Sample Wet-Pipe FSCP Controls Matrix

SYSTEM INPUTS		ANNUNCIATION AT LOCAL PANELS					FIRE SUPPRESSION SYSTEM FUNCTIONS					TRANSMIT SIGNALS TO FIRE DEPARTMENT										AUXILIARY FUNCTIONS				EVACUATION SIGNALS			
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W					
FIRE ALARMS																													
1	Manual Fire Alarm Stations																												
2	Spot-Type Smoke Detectors																												
3	Fixed Temp & Rate-of-Rise Type Heat Detectors																												
4	In-Duct Smoke Detectors																												
5	Rate-Compensated Type Heat Detectors on Hangar Ceiling	X					X	X	X	X						X			X			X							
6	Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems																												
7	Water Flow Switches - Pre-Action Foam-Water Sprinkler Systems	X					X		X	X						X			X			X							
8	Water Switches - Low Level System	X						X	X	X						X			X			X							
9	Manual Foam Discharge Station for Low Level	X					X	X	X	X						X			X			X							
10	Low Level Optical Fire Detector					X																X							
11																													
SUPERVISORY SIGNALS																													
12	Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers																												
13	Valve Supervisory Switches - Foam-Water Sprinklers		X													X													
14	Valve Supervisory Switches - Underwing Foam-Water Nozzles		X													X													
15	Valve Supervisory Switches - Water Supply Entrance		X													X													
16	Hi-Lo Pressure Switches - Dry-Pipe Sprinklers																												
17	Temperature Monitoring System																												
18	UVIR Flame Detector Trouble		X													X													
19	Control Component Common Trouble Condition		X													X													
20	Low Level System Auto Disable Switch		X													X													
21																													
TROUBLE CONDITIONS																													
22	Low Battery Voltage			X																		X							
23	Circuit Fault		X	X																		X							
24	Supervised Component Failure			X																		X							
25	AC Power Failure			X																		X							
26																													

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2. General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3. This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

Figure A4. Sample Pre-Action FSCP Controls Matrix

- Activate the facility fire evacuation alarm system and the foam system annunciation signal.
- Transmit a fire alarm signal to the base fire alarm communications center (fire department). The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment and planned upgrades.

A3.7.3. Optional Low-Level Optical Fire Detectors. The MAJCOM may establish a requirement for low-level optical detection.

A3.7.3.1. Connect low-level optical fire detectors to the foam system control panel (FSCP). Arrange for alarm notification only; do not use optical detection systems to activate any fire suppression system.

A3.7.3.2. Use only combination or dual-spectrum ultraviolet/infrared (UV/IR) type optical detectors, listed/approved by a nationally recognized laboratory. Additionally, the manufacturer must provide a copy of the test report prepared by a nationally recognized laboratory certifying the listed/approved unit will detect a fully developed 3 meter by 3 meter (10 foot by 10 foot) JP-4, JP-8, or JET-A fuel fire at a minimum distance of 45 meters (150 feet) within 5 seconds.

A3.7.3.3. Install a sufficient number of optical detectors such that a fire at any position under an aircraft will be within the range and cone-of-vision of at least one optical detector.

A3.7.3.4. Mount optical detectors approximately 3 meters (10 feet) above the hangar floor level; however, specifics of each design must take into account facility construction, aircraft configuration and positioning, fixed and mobile equipment within the aircraft servicing area, and all other relevant factors. Do not mount optical detectors in inaccessible locations such as under roofs or on roof trusses.

A3.7.3.5. Optical detectors will be of a latching design. Fire detection by any optical detector will immediately:

- Activate the facility fire evacuation alarm system.
- Transmit a fire alarm signal to the fire department.

The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

A3.7.4. Waterflow Detecting Devices. Provide waterflow detecting devices on all fire protection risers with a built-in adjustable (not less than 0 - 90 seconds) retard

on all sprinkler systems. Waterflow will cause the foam system control panel to accomplish the following actions:

- Activate the low-level fuel spill fire suppression systems, if installed.
- Activate the facility fire evacuation alarm system and the foam system annunciation signal.
- Transmit a fire alarm signal to the fire department. The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

A3.7.5. Manual Foam Discharge Stations for Low-Level Fuel Spill Fire Suppression Systems.

A3.7.5.1. Provide manual foam discharge stations inside the aircraft servicing area at exits to actuate the low-level fuel spill fire suppression systems.

A3.7.5.2. Manual foam discharge stations must be distinctively different in shape and color from the fire alarm stations and will have distinctive signage at each device stating "Start FOAM System" in red lettering not less than 76 millimeters (3 inches) high on a lime yellow background.

A3.7.5.3. Manual foam discharge stations must be housed within a clear plastic tamper cover that must be lifted prior to actuating the station.

A3.7.5.4. Actuation of any manual foam discharge stations will cause the FSCP to:

- Activate all nozzles.
- Activate the facility fire evacuation alarm and the foam system annunciation signal.
- Transmit a fire alarm signal to the fire department. The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

A3.7.6. Foam System Signals. Provide blue visual alarm signals (strobe or rotating beacon(s)) within the aircraft servicing area to indicate foam system activation. When the base has adopted a standard audio-visual signal for foam system activation, the signals in this facility will comply fully with that base standard.

A4. Fire Protection System Water Supply.

A4.1. Requirement. Use the base domestic water system for hangar fire protection systems whenever adequate capacity (flow rate and pressure) is available. The A-E is responsible for testing and determining the capability of the

existing systems and integrating those systems with the new systems being designed.

A4.1.1. Provide booster fire pumps IAW paragraph A4.3 when the water flow rate is adequate but pressure is inadequate to meet system pressure demands.

A4.1.2. Provide a separate dedicated fire protection system water supply when the available domestic flow rate is not sufficient to meet the system flow rate demands.

A4.2. Fire Protection Water Storage System.

A4.2.1. Provide water storage tanks IAW NFPA 24. Provide corrosion protection when steel water tanks and associated piping are used.

A4.2.2. Use a single water storage system, when practical, for multiple aircraft facilities. Limit water supply distribution mains from a fire pump station to less than 450 meters (1500 feet). The MAJCOM Fire Protection Engineer may approve a greater length when specific physical situations justify.

A4.2.3. Provide storage capacity equal to 120 percent of the maximum demand for 30 minutes. Divide the required storage capacity between two equal-sized water tanks, each storing one-half of the required volume. The piping configuration must allow water to be supplied by both reservoirs and either of the reservoirs while the other is out of service.

A4.2.4. Provide each tank with a low water level alarm and a low temperature alarm, in areas with a 90% dry bulb temperature less than 0 °C (32 °F), each transmitting back to the fire department as separate supervisory signals. Provide an external visual water-level gauge on each tank.

A4.2.5. Provide automatic refill from the base water distribution system.

A4.3. Fire Protection Water Pump Systems.

A4.3.1. Design and install fire pumping installations IAW NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*. Use a single fire pumping station for multiple aircraft facilities when practical. Limit water supply distribution mains from a fire pump station to less than 450 meters (1500 feet). The MAJCOM Fire Protection Engineer may approve a greater length when specific physical situations justify.

A4.3.2. Fire pumps must have electric motor drivers conforming to NFPA 20 supplied by a single reliable power source. Use dual power sources when a single reliable power source is not available. Use diesel engine drivers only when the installation electrical service fails to meet the reliable standard and dual power sources are not available. The A-E is responsible for determining and documenting the reliability of the existing power sources. A power source is considered reliable when the following are not exceeded:

- Forced downtime, excluding scheduled repairs, more than 8 consecutive hours for any one incident over the previous 3 years;

and

- 24 cumulative hours downtime during the previous year.

A4.3.3. Use "soft start" or variable frequency fire pump controllers when electric-driven fire pumps are installed.

A4.3.4. Limit the maximum rated fire pump size to 9.463m³pm (9463 lpm) (2500 gpm) at 862 kPa (8.5 bar) (125 psi).

A4.3.5. Provide pressure maintenance pumps ("jockey pumps") to maintain normal operating pressure on the system and to compensate for normal system leakage. See NFPA 20, paragraph 19, for jockey pump flow requirements. The jockey pump's rated pressure must be sufficient for the startup and shutdown pressures specified in NFPA 20. Set jockey pump controllers to automatically start and stop IAW paragraph A-11-2.6 of NFPA 20. Provide run timers to ensure that the jockey pump will run for at least the minimum time recommended by the manufacturer of the jockey pump's motor.

A4.3.6. Ensure the fire pumping system will have capacity to meet the maximum water demand when the largest capacity pump is out of service.

A4.3.7. Arrange multiple-pump installations for sequential starting at 10-second intervals until the required pressure is maintained by the operating pumps. The starting sequence will begin automatically as follows:

- Drop of water pressure in the system IAW NFPA 20.
- A pump start signal transmitted from the foam system control panel in the protected facility.

A4.3.8. Provide connection through the installation fire reporting system to notify the fire department of pump running signals, pump system trouble, tamper and supervisory signals provided by the fire pump controllers.

A4.3.9. Provide surge arresters to moderate the potentially destructive effects of pressure surges or water hammer due to pump starting and stopping and valve

opening and closing. These hydropneumatic devices absorb pressure surges into a precalculated volume of captive gas and return the absorbed water volume to the system in a controlled fashion. Surge arresters are installed on the system side of the fire pump discharge check valve and as close to the valve as possible. Not less than one arrester will be provided for each pump and each must be listed/approved as a surge arrester for fire protection piping with a volume of not less than 10 gallons and a rated working pressure not less than 3445 kPa (500 psi). Provide each arrester with an indicating valve to isolate it from the system. Supervision is not required. Because of the complex effects of system variables on satisfactory performance, each surge arrester installation should be engineered by the manufacturer.

A5. Facility Fire Detection and Alarm System. Design all facility fire detection and alarm systems IAW NFPA 72 and the following criteria.

A5.1. Fire Alarm Control Panel (FACP).

A5.1.1. Locate all FACPs in a clean environment having temperature and humidity control IAW the unit's listing/approval.

A5.1.2. Transient Voltage Surge Suppression (TVSS). All FACPs will have TVSS on all fire alarm circuits entering and leaving the facility, including but not limited to the power supply circuits to the FACP, circuits interfacing with fire pumping stations outside the facility, and circuits interfacing with the fire alarm receiving station (such as communication circuits or antenna systems). TVSS devices must comply with the requirements of A.3.7.1.2.

A5.1.3. Provide a single FACP for all detection alarm functions in the facility not part of the foam-water fire suppression system. The FACP must be fully compatible with the base fire alarm receiving system without field modifications to any system hardware or software.

A5.1.4. Separate fire alarm transmitters/receivers are permitted when they are fully compatible with the FACP and the base fire alarm receiving system without field modifications to the FACP.

A5.1.5. The specific number of alarm signals to be transmitted will be defined in the system matrix (Figure A5).

A5.2. Manual Fire Alarm Stations (Pull Stations).

A5.2.1. Provide pull stations throughout the facility at all exit doors. Additional pull stations will be provided when required by NFPA 101.

SYSTEM INPUTS

	ANNUNCIATION AT LOCAL PANELS				FIRE SUPPRESSION SYSTEM FUNCTIONS								TRANSMIT SIGNALS TO FIRE DEPARTMENT								AUXILIARY FUNCTIONS				EVACUATION SIGNALS			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W					
SYSTEM INPUTS																												
FIRE ALARMS																												
1	X													X					X		X							
2	X												X					X	X		X							
3	X												X					X	X		X							
4	X												X					X	X		X							
5																												
Rate-Compensated Type Heat Detectors on Hangar Ceiling																												
6	X													X				X			X							
Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems																												
7																					X							
Water Flow Switches - Pre-Action Foam-Water Sprinkler Systems																												
8																					X							
Water Switches - Under-Aircraft Foam-Water Nozzles																												
9																					X							
Manual Foam Discharge Station for Nozzles																												
10																					X							
Low Level Optical Fire Detector																												
11																					X							
SUPERVISORY SIGNALS																												
12																												
Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers																												
13	X																											
Valve Supervisory Switches - Foam-Water Sprinklers																												
14																												
Valve Supervisory Switches - Underwing Foam-Water Nozzles																												
15																												
Valve Supervisory Switches - Water Supply Entrance																												
16	X																											
Hi-Lo Pressure Switches - Dry-Pipe Sprinklers																												
17																												
Temperature Monitoring System																												
18				X																								
UV/IR Flame Detector Trouble																												
19	X																											
Control Component Common Trouble Condition																												
20																												
Under-Aircraft Foam-Water System Auto Disable Switch																												
21																												
TROUBLE CONDITIONS																												
22			X																									
Low Battery Voltage																												
23	X		X																									
Circuit Fault																												
24			X																									
Supervised Component Failure																												
25			X																									
AC Power Failure																												
26																												

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2. General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3. This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

Figure A5. Sample FACP Controls Matrix

A5.2.2. Ensure all manual alarm activation stations are identical throughout the facility. If the base has established a formal base-wide standard for manual pull stations, the pull stations in facilities governed by this ETL will comply fully with that standard.

A5.2.3. Actuation of any pull station will immediately cause the FACP to:

- Activate the facility fire evacuation alarm signal throughout the facility.
- Transmit a fire alarm signal to the base fire department.

A5.3. Fire Alarm Notification. Provide audio-visual alarm notification devices. When the base has a standard for audible sound (e.g., slow whoop, bell) and visual signal (red, white), the devices in this facility will comply fully with the base standard(s). No other system (hangar doors, alert signal) will be permitted to use these signals. The fire alarm must be distinctive in high noise areas.

A5.4. Temperature Monitoring System.

A5.4.1. Provide a system of temperature sensors for the aircraft servicing area in all geographic areas having a 99% dry bulb temperature less than -1 °C (30 °F) when wet-pipe sprinkler systems are present. The temperature sensors will be located at the same level as the sprinkler piping spaced not more than 60 meters (200 feet) apart. Provide this temperature monitoring to ensure a warning when freezing temperatures endanger sprinkler piping.

A5.4.2. This facility temperature monitoring system will be tied into the FACP as a dedicated supervisory zone, and this supervisory signal will be transmitted to the fire department in the same manner as all fire-related supervisory signals in the facility.

A6. Design and Construction Management.

A6.1. Architect-Engineer (A-E) Qualifications.

A6.1.1. It is mandatory that the design organization (whether the design is accomplished by the Design Agent in-house or through an outside A-E firm) use a qualified Fire Protection Engineer, experienced in the design of aircraft hangars, for the design of the fire protection systems in all Air Force projects covered by this ETL.

A6.1.1.1. "Qualified Fire Protection Engineer" does not have a universal definition and is defined differently among various government agencies. For this ETL, one

of the following credentials is required to meet the criteria for "qualified Fire Protection Engineer":

- Bachelor of Science or Master of Science degree in fire protection engineering from an accredited university, plus a minimum of 5 years' work experience in fire protection engineering.
- Professional Engineer (PE) registration by examination, National Council of Examiners for Engineering and Surveys (NCEE) fire protection engineering written examination.
- Qualification as a GS/GM 804-series fire protection engineer.
- Professional Engineer (PE) registration in a related discipline with a minimum of 5 years' work experience in fire protection engineering.

A6.1.1.2. For Air Force aircraft hangars, the Design Agent will confirm that: (1) the designer complies with the definition of "qualified Fire Protection Engineer" above; and (2) that the Fire Protection Engineer has substantial experience in the design and construction of aircraft hangar fire protection systems of similar complexity.

A6.1.2. The Commerce Business Daily announcement for the project design will specifically include the requirement for a qualified Fire Protection Engineer on the A-E design team.

A6.2. System Testing and Acceptance.

A6.2.1. Preliminary Testing.

A6.2.1.1. Testing of the fire protection system is critical. The entire fire protection system must be tested in accordance with the specification to assure that all equipment, components, and subsystems function as intended. In addition to establishing written confirmation of all test results, all preliminary tests will be videotaped to record the methods and equipment employed to conduct the tests.

A6.2.1.2. A copy of the videotape must be submitted with a copy of the proposed test plan to the CoE Center of Expertise or NAVFACENGCOM FPE before the request for a final acceptance test is made. All preliminary tests must be completed prior to scheduling the final acceptance test.

A6.2.2. Final Acceptance Test. The final test will be a repeat of all preliminary tests, except that flushing and hydrostatic tests will not be repeated. Tests must be witnessed by the CoE Center of Expertise or NAVFACENGCOM FPE. All system failures or other deficiencies identified during the testing must be corrected and retested in the presence of the CoE Center of Expertise or NAVFACENGCOM FPE.

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